





## Effect on alfalfa genotypes (*Medicago sativa* L. cv. Vernal & Maris kabul)

### 1. The net impact of individual and combined stress on plant growth

Crop: Alfalfa (*Medicago sativa* L.) cv. Vernal & Maris kabul  
 Stress 1: *Pratylenchus penetrans*, *Ditylenchus dipsaci*  
 Stress 2: *Verticillium albo-atrum*  
 Stage of plant: At sowing, 3 weeks after stress1



The table shows the impact of nematode and fungus alone and in combination on the forage yield of alfalfa genotypes.

	Treatment	Plant response to stress (reduction over control %)	
		Type A parameters	
		Forage yeild Year 1983	Forage yeild Year 1984
Maris kabul	<i>Ditylenchus dipsaci</i> (30 nematodes/seed ) + <i>Verticillium albo-atrum</i> (17 days later) ( $10^8$ spores/ml) Sequential stress	N/A	N/A
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (25 days later) ( $10^8$ spores/ml) Sequential stress	N/A	N/A
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (31 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	N/A	N/A
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (38 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	N/A	N/A
	<i>Verticillium albo-atrum</i> ( $10^8$ spores/ml)	0	0
	<i>Pratylenchus penetrans</i> (1000 nematodes/seed )+ <i>Verticillium albo-atrum</i> ( $10^8$ spores/ml) (simultaneous stress)	6.94 ↓	8 ↓

Vernal	<i>Ditylenchus dipsaci</i> (30 nematodes/seed ) + <i>Verticillium albo-atrum</i> (17 days later) ( $10^8$ spores/ml) Sequential stress	N/A	N/A
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (25 days later) ( $10^8$ spores/ml) Sequential stress	N/A	N/A
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (31 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	N/A	N/A
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (38 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	N/A	N/A
	<i>Verticillium albo-atrum</i> ( $10^8$ spores/ml)	0	0
	<i>Pratylenchus penetrans</i> (1000 nematodes/seed )+ <i>Verticillium albo-atrum</i> ( $10^8$ spores/ml) (simultaneous stress)	-0.88 	3.61 

**Note:** Values presented in the table were calculated using the formula described below.

$$\text{Reduction over control (\%)} = \frac{(\text{Value Control} - \text{Value Stress})}{\text{Value Control}} \times 100$$

- 1) '- indicates plant parameters affected by stress that lead to high susceptibility (higher the value more the damage).
  - 2) '- indicates plant parameters less/not affected by stress leading to improved resistance (higher the value lesser the damage).
  - 3) "0.0" value indicates plant parameter behaved similarly under control and stress condition (no damage).
- \*' - For more information on parameters classification, please refer to 'methodology' tab.

## 2. The interaction between nematode and fungal pathogen under combined stress at plant interface

The table shows the effect of the fungal pathogen on fungus induced wilt complex in presence of nematodes under combined stress treatment

	<b>Treatment</b>	<b>Response to combined stress**</b>	
		<b>Type B parameters*</b>	
		<b>Verticillium wilt rating index</b>	
		<b>Without nematodes</b>	<b>With nematodes</b>
<b>Maris kabul</b>	<i>Ditylenchus dipsaci</i> (30 nematodes/seed ) + <i>Verticillium albo-atrum</i> (17 days later) ( $10^8$ spores/ml) Sequential stress	1.48	1.43
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (25 days later) ( $10^8$ spores/ml) Sequential stress	1.64	1.61
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (31 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	1.7	1.71
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (38 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	1.78	1.83
	<i>Verticillium albo-atrum</i> ( $10^8$ spores/ml)	N/A	N/A
	<i>Pratylenchus penetrans</i> (1000 nematodes/seed )+ <i>Verticillium albo-atrum</i> ( $10^8$ spores/ml) (simultaneous stress)	N/A	N/A
<b>Vernal</b>	<i>Ditylenchus dipsaci</i> (30 nematodes/seed ) + <i>Verticillium albo-atrum</i> (17 days later) ( $10^8$ spores/ml) Sequential stress	1.73	2
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (25 days later) ( $10^8$ spores/ml) Sequential stress	1.88	2.31
	<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (31 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	1.99	2.39

<i>Ditylenchus dipsaci</i> (30 nematodes/seed )+ <i>Verticillium albo-atrum</i> (38 days later) ( $10^8$ spores/ml) Sequential stress Sequential stress	2.11	2.77
<i>Verticillium albo-atrum</i> ( $10^8$ spores/ml)	N/A	N/A
<i>Pratylenchus penetrans</i> (1000 nematodes/seed )+ <i>Verticillium albo-atrum</i> ( $10^8$ spores/ml) (simultaneous stress)	N/A	N/A

For raw data – Click here (.xlsx file)

Reference- Vrain TC (1987) Effect of *Ditylenchus dipsaci* and *Pratylenchus penetrans* on *Verticillium* Wilt of Alfalfa. Journal of Nematology 19(3):379-383

**Note:**

‘\*\*\*’ - Values are presented as it is from the source article without subjecting to the calculation.

‘\*’ - For more information on parameters classification, please refer to ‘methodology’ tab.

**Inference From the study:** Vrain TC 1987 studied the interaction of *Verticillium albo-atrum* and two nematode species *Pratylenchus penetrans* and *Ditylenchus dipsaci* on alfalfa cultivars vernal and Maris kabul. Yield studies were made during the year 1983 and 1984 in an interaction between *Verticillium albo-atrum* and *Pratylenchus penetrans* showing a reduction in yield in 1984 compared to in year 1983 in both cultivars. Disease ratings were calculated using *Verticillium albo-atrum* and *Ditylenchus dipsaci* showing an additive increase in wilt rating compared to single pathogen inoculation in vernal but not in maris kabul. Thus, to conclude, both nematode species show an additive effect in forming a disease complex with *V. albo-atrum* and reducing plant growth in the vernal cultivar.